REDUCED EMISSIONS TRANSPORTATION FUEL

The invention relates to reduced emissions transportation fuels, formulated to reduce emissions of toxics, hydrocarbons (VOCs) and NO_x. More particularly, the invention relates to transportation fuels that are formulated to reduce emissions of toxics, hydrocarbons (VOCs) and NO_x, and have reduced sulfur content.

BACKGROUND OF THE INVENTION

There are many challenges for U.S. refiners to produce fuels that comply with environmental regulations and meet vehicle performance requirements. Federal and State Governments have regulated gasoline properties for many years. Generally, these regulations were developed to meet air quality goals. In 1990, the Federal Government issued the Clean Air Act Amendments, which required significant changes to gasoline used in certain areas of the United States.

Beginning January 1, 1998, refiners had to certify their reformulated gasolines using the EPA Complex Model, a computer model that predicts emissions performance. The properties used in the Complex Model to predict emissions performance are: methyl tert-butyl ether (MTBE) (wt.% oxygen), ethyl tert-butyl ether (ETBE) (wt.% oxygen), Ethanol (wt.% oxygen), Methanol (wt.% oxygen), tert-amyl methyl ether (TAME) (wt.% oxygen), sulfur (ppm), Reid Vapor Pressure (psi), 50% D-86 distillation point (°F) or E200(%), 90% D-86 distillation point (°F) or E300(%), aromatics (vol%), olefins (vol%), and benzene (vol%).

U.S. Patents No. 5,288,393, 5,593,567, 5,653,866, 5,837,126 and 6,030,521 indicate that the primary factor effecting NO_x emissions is Reid Vapor Pressure (RVP),

with the 10% D-86 Distillation Point and Olefins content being of secondary importance. It is reported that since reductions in 10% D-86 Distillation Point are often unacceptable for performance reasons, olefins content is generally to be used as the secondary variable in decreasing NO_x emissions. These U.S. Patents report that a Reid Vapor Pressure of less than 8.0 psi and an olefins content not exceeding 15% by weight are preferred for NO_x emissions reductions. These U.S. Patents also reports that 50% D-86 and distillation points not exceeding 215 °F are preferred for reducing hydrocarbon and carbon monoxide emissions.

An olefins content of less than 15% by weight is generally not difficult to achieve in high octane blends, such as 93 octane gasoline, since these fuels are generally low in olefins due to the components used to produce them. However, it is more difficult to achieve this olefins content in lower octane fuels, such as 87 octane, because of the high olefins content of the components used to produce these fuels.

An additional issue facing refiners is the pending implementation of the EPA Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements. Beginning in 2004, refiners must produce gasoline that averages 120ppm sulfur with a batch limit of 300ppm. In 2005, gasoline sulfur levels must average 90ppm with a 300ppm cap, and in 2006, these limits are a 30ppm average with an 80ppm cap.

It is desirable to produce transportation fuels that meet the emissions reductions requirements determined using EPA Complex Model and can be produced using components having a high concentration of olefins. It is further desirable to produce transportation fuels that meet the emissions reductions requirements using the EPA Complex Model and have reduced sulfur content.

SUMMARY OF THE INVENTION

The current invention provides transportation fuels that meet the emissions requirements for toxics, VOC and NO_x as determined using the EPA Complex Model. Reductions in NO_x emissions are achieved primarily by controlling the 90% D-86 distillation point, olefins content, aromatics content and sulfur content. Reductions in VOC emissions are achieved primarily by controlling Reid Vapor Pressure and secondarily by controlling aromatics content. Reductions in toxics emissions is achieved primarily by controlling aromatics and benzene content, 90% D-86 distillation point and the use of oxygenates. Transportation fuels according to the current invention can have olefins content from about 0- 25% by weight, preferably about 15 -25%. Sulfur content in transportation fuels according to the current invention is less than about 300ppm, preferably less than about 120ppm, and most preferably less than about 80ppm. Reduced sulfur content in transportation fuels according to the current invention allows higher olefins content and higher 50 and 90% D-86 distillation points than would otherwise be required for meeting emissions reduction requirements.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to transportation fuels blended to comply with the requirements for emissions reduction, determined using the EPA Complex Model. The EPA Complex Model uses the following parameters for estimating NO_x, VOC and toxics emissions: methyl tert-butyl ether (wt.% oxygen), ethyl tert-butyl ether (wt.% oxygen), ethanol (wt.% oxygen), methanol (wt.% oxygen), tert-amyl methyl ether (wt.% oxygen),

sulfur (ppm), Reid Vapor Pressure, D-86 50% distillation point (°F) or E200 (%), D-86 90% distillation point (°F) or E300 (%), aromatics (volume %), olefins (volume %) and benzene (volume %). As defined in the complex model, the wt. % oxygen contributed by an oxygenating component, such as methyl tert-butyl ether, is the percent oxygen content in the fuel blend on a total weight basis. As defined in the EPA Complex Model, the E200 (%) and E300 (%) are the percentages of a fuel that vaporizes at 200°F and 300°F respectively.

Fuels according to the current invention were blended to comply with the requirements for reductions in NO_x emissions by controlling at least one of the following properties from the EPA Complex Model: the 90% D-86 distillation point, olefins content, aromatics content and sulfur content, as indicated in the tables. VOC emissions are controlled by controlling Reid Vapor Pressure and aromatics content. Toxics emissions are controlled by controlling aromatics and benzene content, 90% D-86 distillation point and the use of oxygenates.

According to one embodiment, fuels of the current invention have octane ratings of 94 (R+M)/2 or lower, preferred octane ratings being 87, 93 and 94. The 50% D-86 distillation point of fuels according to this embodiment of the invention is less than about 235°F, preferably from about 215°F to about 235°F. The 90% D-86 distillation point of fuels according to this embodiment of the invention is less than about 360°F, preferably from about 315°F to about 360°F. Olefins content of fuels according to this embodiment of the invention is less than about 25%, preferably from about 15% to about 25%. Aromatics content of fuels according to this embodiment of the invention is less than about 47%, preferably from about 20% to about 40%. Sulfur content for fuels according

to this embodiment of the invention is less than about 300ppm. Preferably, the sulfur content of fuels according to this embodiment of the invention is about 120 ppm or less, more preferably about 80 ppm or less.

Fuels according to this embodiment of the invention fall into two basic categories, oxygenated and non-oxygenated fuels. For the purposes of the invention, non-oxygenated fuels are those fuels that contain less than 0.1% oxygen by weight. In preferred embodiments, oxygen can be introduce by using oxygenating components, such as: ethyl tert-butyl ether (EtBE), methyl tert-butyl ether (MtBE), tert-amyl methyl ether (TAME), ethanol and methanol. Selection of a particular oxygenating component is within the purview of an individual skilled in the art.

It will be recognized that the examples presented here are for illustrative purposes only and should not be construed as placing a limitation upon the scope of the invention. Further the development of procedures for blending hydrocarbon streams to achieve fuels having the desired content of the several components listed in **Tables 1, 2, 3** and **4** can be carried out by one skilled in the art, without undue experimentation. Methods for developing procedures for blending hydrocarbon streams to produce fuels having the desired content of aromatics, olefins, etc., as well as 10, 50 and 90% D-86 distillation points include, but are not limited to, linear programming and non-linear programming. Those skilled in the art will recognize that the fuel blends of the current invention are not limited to a particular method of developing blending procedures to produce them.

Tables 1, 2, 3 and **4** show examples of transportation fuels of various octane ratings according to the current invention. The examples shown in **Tables 1, 3** and **4** are oxygenated fuels. **Table 2** shows non-oxygenated fuels. The values presented for olefins

and aromatics content in **Tables 1, 2, 3** and **4** are not corrected for content of oxygenates. **Tables 5, 6,** 7 and **8** show emissions of toxics, VOCs and NO_x for the fuels shown in **Tables 1, 2, 3** and **4**, and reductions versus emissions for an industry average baseline fuel calculated using the EPA Complex Model. The industry average baseline fuel has the following properties: 339ppm sulfur, 1.53% benzene, 8.7psi RVP, 87.3(R+M)/2, 128F T10, 218F T50, 330F T90, 32% aromatics, 9.2% olefins and 58.8% saturates. These values represent average 1990 nationwide (excluding California) gasoline composition.

The values for aromatics, benzene, olefins and sulfur content reported in **Tables 1, 2, 3** and **4** were corrected for oxygen content prior to being used to calculate emissions for the example fuels in the EPA Complex Model.

The data from **Tables 5, 6,** 7 and **8** show a decrease in emissions of toxics, VOCs and NO_x versus the baseline fuel. **Table 6** shows emissions for non-oxygenated fuels. **Tables 5,** 7 and **8** show emissions for oxygenated fuels according to a preferred embodiment. Emissions values for toxics, NO_x and VOCs is reported in mg/mile. The values for percentage reduction are calculated versus an industry average baseline fuel. In addition, all fuels according to this embodiment meet the EPA requirement of not more than 300 ppm sulfur. Non-oxygenated fuels according to the current invention show a reduction in toxics emissions of up to about 28%, a reduction in NO_x emissions of up to about 14%, and a reduction in VOC emissions of up to about 22% versus an industry average baseline fuel. Oxygenated fuels according to the current invention show a reduction in toxics emissions of up to about 40%, a reduction in NO_x emissions of up to

about 16%, and a reduction in VOC emissions of up to about 36% versus an industry average baseline fuel.

According to another embodiment, the current invention provides a blend stock for use in blending with oxygenates to produce an oxygenated fuel. Blend stocks according to this embodiment have an octane rating of at least 83.5 and are suitable for blending with oxygenates to produce a reduced emissions transportation fuel. Blend stocks according to this embodiment of the invention have a 50% D-86 distillation point of less than about 232°F, preferably from about 215°F to about 232°F, and a 90% D-86 distillation point less than about 360°F, preferably from about 315°F to about 360°F. The aromatics content of blend stocks according to this embodiment of the invention is less than about 33%, preferably from about 14% to about 33%. The olefins content of blend stocks according to this embodiment of the invention is less than about 21%, preferably from about 15% to about 21%.

Blend stocks according to this embodiment of the invention are blended with an oxygenating component to produce an oxygenated transportation fuel. Such oxygenating components include ethyl tert-butyl ether (EtBE), methyl tert-butyl ether (MtBE), tert-amyl methyl ether (TAME), ethanol and methanol.

A preferred embodiment provides a blend stock having an octane rating of 83.5. According to this embodiment, the blend stock is blended with ethanol to produce a transportation fuel having an octane rating of from about 87 to about 90. **Table 9** shows examples of fuels produced from a blend stock according to this preferred embodiment, blended with ethanol. **Table 10** shows emissions data for the examples in **Table 9**. Fuels produced from blend stocks according to this embodiment show a reduction in toxics

emissions of up to about 26%, a reduction in NO_x emissions of up to about 10%, and a reduction in VOCs of up to about 25%. Reductions in emissions were determined versus an industry standard baseline fuel.

TABLE 1: 87 RFG Blends

Batch ID	Octane Rating	RVP psi	Aromatic cont. (%)	Benzene cont. (%)	Olefins cont. (%)	D86 50% °F	D86 90% °F	Sulfur ppm	MtBE cont. (%)	EtBE cont. (%)	TAME cont. (%)	Methanol cont. (%)	Ethanol cont. (%)	oxygen cont. (%)
0001	87	6.83	16.85	0.28	13.93	208	352	156	1.858	0	0	0	0	1.858
0002	87	6.35	15.94	0.62	17.17	193	343	203	2.541	0	0.016	0.025	0	2.582
0003	87	6.83	16.47	0.55	15.78	190	336	34	2.503	0	0	0	0	2.503
0004	87	6.60	24.81	0.57	11.57	219	316	102	1.949	0	0	0	0	1.949
0005	87	6.92	22.48	0.82	11.66	195	337	126	2.104	0	0	0	0	2.104
0006	87	7.31	23.51	0.54	11.76	188	331	135	2.092	0	0.005	0	0	2.097
0007	87	6.83	18.68	0.56	23.63	193	348	143	2.679	0	0.002	0	0	2.681
0008	87	6.69	18.02	0.53	12.37	182.8	336	146	2.6	0	0.002	0	0	2.602
0009	87	7.31	23.45	0.49	12.75	197	340.7	154	2.042	0	0.004	0	0	2.046
0010	87	7.03	22.36	0.47	10.76	195	347	166	1.945	0	0	0	0	1.945
0011	87	6.35	20.76	0.45	12.22	201	343	168	2.374	0	0	0	0	2.374
0012	87	7.06	23.17	0.45	13.44	209	347	171	1.782	0	0	0	0	1.782
0013	87	6.66	17.98	0.43	19.5	196	343	172	2.683	0	0.014	0.2	0	2.897
0014	87	6.56	34.25	0.58	18.06	198	341	189	2.626	0	0.002	0	0	2.628
0015	87	7.18	12.8	0.59	12.82	191.6	321.6	190	2.597	0	0	0	0	2.597
0016	87	6.73	23.81	0.5	15.93	219	347	239	2.584	0	0	0	0	2.584
0017	87	6.9	15.87	0.49	19.73	201	353	284	2.579	0	0	0	0	2.579
0018	87	6.57	17.09	0.57	19.44	197	348	298	2.312	0	0.008	0	0	2.32

TABLE 2: 93N Blends

Batch ID	Octane Rating	RVP psi	Aromatic cont. (%)	Benzene cont. (%)	Olefins cont. (%)	D86 50% °F	D86 90% °F	Sulfur ppm	MtBE cont. (%)	EtBE cont. (%)	TAME cont. (%)	Methanol cont. (%)	Ethanol cont. (%)	oxygen cont. (%)
0019	93	6.63	31.86	0.59	7.71	230	319	41	0.03	0	0	0	0	0.03
0020	93	6.47	30.76	0.59	1.2	234	316	27	0.039	0	0	0	0	0.039
0021	93	6.15	27.33	0.45	1.3	231.7	312.1	34	0.049	0	0	0	0	0.049
0022	93	6.19	28.73	0.73	3.11	228	308	34	0.046	0	0	0	0	0.046
0023	93	6.4	36.18	0.82	4.8	227	312	36	0.016	0	0	0	0	0.016
0024	93	6.44	31.47	0.62	8.61	232.2	321.8	42	0.03	0	0	0	0	0.03
0025	93	6.54	24.1	0.55	5.71	224	310	57	0.028	0	0	0	0	0.028
0026	93	6.5	34.59	0.74	7.61	228	316	66	0.03	0	0	0	0	0.03
0027	93	6.5	35.73	0.77	3.3	231	317	25	0.16	0	0	0	0	0.016
0028	93	6.58	35.97	0.86	4.9	228.9	313.4	24	0.015	0	0	0	0	0.015
0029	93	6.7	35.19	0.61	3.81	229.5	321.6	27	0.03	0	0	0	0	0.03
0030	93	6.45	30.37	0.54	6.01	230	320	32	0.019	0	0	0	0	0.019
0031	93	6.44	28.05	0.6	5.41	229	310	42	0.043	0	0	0	0	0.043
0032	93	6.51	25.77	0.56	5.41	227	319	70	0.035	0	0	0	0	0.035

TABLE 3: 93RFG Blends

Batch ID	Octane Rating	RVP psi	Aromatic cont. (%)	Benzene cont. (%)	Olefins cont. (%)	D86 50% °F	D86 90% °F	Sulfur ppm	MtBE cont. (%)	EtBE cont. (%)	TAME cont. (%)	Methanol cont. (%)	Ethanol cont. (%)	oxygen cont. (%)
0033	93	6.72	25.31	0.34	9.77	216	330	3	2.507	0	0	0	0	2.507
0034	93	6.69	31.05	0.48	5.08	219.7	325.3	65	2.387	0	0	0	0	2.387
0035	93	6.82	30.39	0.55	7.17	219	328	84	2.166	0	0	0	0	2.166
0036	93	6.66	36.31	0.72	9.36	222.8	332.8	88	1.98	0	0	0	0	1.98
0037	93	6.4	35.52	0.56	9.46	220	327	90	2.163	0	0	0	0	2.163
0038	93	6.76	36.97	0.65	11.48	217.2	328.5	90	2.559	0	0	0	0	2.559
0039	93	6.43	21.73	0.29	10.78	212	328	97	2.628	0	0	0	0	2.628
0040	93	6.61	22.66	0.3	9.84	212	328	102	2.642	0	0	0	0	2.642
0041	93	6.53	26.53	0.37	13.33	213.5	328.7	106	2.575	0	0.002	0	0	2.577
0042	93	6.87	35.31	0.63	13.26	209.5	330.8	108	2.593	0	0	0	0	2.593
0043	93	6.89	25.59	0.39	11	212	327	110	2.604	0	0.002	0	0	2.606
0044	93	7.02	32.14	0.6	11.81	209	322	114	2.561	0	0	0	0	2.561
0045	93	6.76	26.2	0.42	13.17	222.8	332.8	272	2.535	0	0.004	0	0	2.539
0046	93	6.85	27.63	0.53	7.34	217	328	83	2.042	0	0	0	0	2.042
0047	93	6.93	30.52	0.44	10.87	211	329	102	2.237	0	0.002	0	0	2.239
0048	93	6.47	25.82	0.45	10.06	215.1	327.5	94	2.587	0	0.005	0	0	2.592
0049	93	6.76	22.17	0.31	11.36	214	331	84	2.618	0	0	0	0	2.618
0050	93	6.7	23.36	0.32	11.71	212	332	95	2.625	0	0.002	0	0	2.627

TABLE 4: 94 RFG Blends

Batch ID	Octane Rating	RVP psi	Aromatic cont. (%)	Benzene cont. (%)	Olefins cont. (%)	D86 50% °F	D86 90% °F	Sulfur ppm	MtBE cont. (%)	EtBE cont. (%)	TAME cont. (%)	Methanol cont. (%)	Ethanol cont. (%)	oxygen cont. (%)
0051	94	6.6	26.42	0.39	2.18	221	313	18	2.33	0	0.002	0	0	2.332
0052	94	6.67	25.46	0.39	15.49	214.5	325.3	30	2.643	0	0	0	0	2.643
0053	94	6.76	29.17	0.4	1.25	220	304	44	2.184	0	0	0	0	2.184
0054	94	6.48	25.37	0.38	1.8	218	304	52	1.971	0	0	0	0	1.971
0055	94	6.35	31.14	0.5	9.44	219.3	323.3	54	2.518	0	0	0	0	2.518
0056	94	6.57	37.21	0.49	7.87	221	314	56	2.657	0	0	0	0	2.657
0057	94	6.7	22.82	0.27	5.05	216	316	62	2.67	0	0.002	0	0	2.672
0058	94	6.41	34.5	0.63	7.52	220	320	65	2.388	0	0	0	0	2.388
0059	94	6.56	29.31	0.41	2.52	228	312	67	2.289	0	0	0	0	2.289
0060	94	6.7	22.15	0.34	5.18	217	318	69	2.726	0	0.002	0	0	2.728
0061	94	6.5	36.58	0.7	8.27	219.6	318.9	70	2.486	0	0	0	0	2.486
0062	94	6.61	45.97	0.33	12.26	219	314	71	2.554	0	0	0	0	2.554
0063	94	6.43	37.22	0.51	10.22	223	323	79	2.258	0	0	0	0	2.258
0064	94	6.86	26.9	0.41	12.96	211	323	82	2.575	0	0	0	0	2.575
0065	94	6.53	22.62	0.36	3.34	217	307	84	2.393	0	0	0	0	2.393
0066	94	6.74	29.41	0.44	9.6	219	331	96	2.589	0	0	0	0	2.589
0067	94	6.6	32.09	0.49	7.26	219.3	325.8	111	2.587	0	0.005	0	0	2.592

TABLE 5: 87 RFG Blends

Batch ID	total toxics mg/mi.	% reduc. toxics	total NO_x mg/mi.	% reduc. NO_x	total VOC mg/mi.	% reduc. VOC
0001	53.663	37.85	1220.804	8.89	1009.539	31.15
0002	54.617	36.75	1260.524	5.93	943.339	35.67
0003	51.757	40.06	1161.106	13.35	960.592	34.49
0004	57.1	33.87	1198.895	10.53	1009.908	31.13
0005	57.73	33.14	1218.239	9.08	1013.739	30.86
0006	55.512	35.71	1231.645	8.09	1050.877	28.33
0007	55.614	35.59	1310.781	2.18	974.642	33.53
0008	52.42	39.29	1213.766	9.42	965.87	34.13
0009	56.221	34.89	1244.89	7.10	1067.402	27.20
0010	55.912	35.24	1237.985	7.61	1045.064	28.73
0011	54.525	36.85	1228.115	8.35	974.231	33.56
0012	57.583	33.31	1255.382	6.31	1069.352	27.07
0013	53.964	37.50	1273.615	4.95	970.785	33.794
0014	60.783	29.60	1323.784	1.21	1014.197	30.83
0015	52.563	39.12	1210.381	9.67	1015.472	30.75
0016	57.985	32.84	1292.061	3.58	1040.895	29.01
0017	56.083	35.05	1318.623	1.60	1008.762	31.20
0018	57.318	33.62	1333.292	0.50	980.26	33.15

TABLE 6: 93N Blends

Batch ID	total toxics mg/mi.	% reduc. toxics	total NO_x mg/mi.	% reduc. NO_x	total VOC mg/mi.	% reduc. VOC
0019	65.15	24.55	1171.869	12.55	1171.869	20.08
0020	64.189	25.66	1148.856	14.26	1148.856	21.65
0021	61.009	29.34	1145.354	14.53	1145.354	21.89
0022	64.495	25.30	1150.499	14.14	1150.499	21.54
0023	70.126	18.78	1164.217	13.12	1164.217	20.60
0024	65.794	23.80	1172.023	12.54	1172.023	20.07
0025	60.718	29.68	1156.487	13.70	1156.487	21.13
0026	68.982	20.11	1188.81	11.28	1188.81	18.93
0027	68.993	20.10	1156.441	13.70	1156.441	21.13
0028	70.24	18.65	1157.309	13.63	1157.309	21.07
0029	66.628	22.83	1160.761	13.38	1160.761	20.84
0030	63.824	26.08	1154.843	13.82	1154.843	21.24
0031	63.285	26.71	1153.867	13.89	1153.867	21.31
0032	62.031	28.16	1167.365	12.88	1167.385	20.39

TABLE 7: 93 RFG Blends

Batch ID	total toxics mg/mi.	% reduc. toxics	total NO_x mg/mi.	% reduc. NO_x	total VOC mg/mi.	% reduc. VOC
0033	52.728	38.93	1131.315	15.57	1008.601	31.22
0034	56.823	34.19	1174.724	12.33	1042.582	28.90
0035	58.161	32.64	1188.805	11.28	1054.784	28.07
0036	63.21	26.79	1209.203	9.76	1066.4	27.27
0037	60.566	29.86	1208.29	9.83	1031.563	29.65
0038	61.071	29.27	1218.305	9.08	1053.511	28.15
0039	52.155	39.60	1177.518	12.13	980.074	33.16
0040	52.396	39.32	1181.889	11.80	995.448	32.11
0041	54.755	36.59	1213.297	9.46	996.42	32.05
0042	60.195	30.28	1239.889	7.47	1048.015	28.53
0043	54.314	37.10	1202.598	10.25	1026.829	29.97
0044	58.593	32.14	1229.95	8.21	1051.698	28.28
0045	57.535	33.37	1295.935	3.29	1033.95	29.49
0046	57.107	33.86	1183.611	11.67	1047.105	28.59
0047	57.147	33.82	1216.821	9.19	1045.436	28.70
0048	54.774	36.56	1187.554	11.38	998.079	31.93
0049	54.482	39.22	1174.942	12.32	1007.71	31.28
0050	52.954	38.67	1188.511	11.31	1002.73	31.62

TABLE 8: 94 RFG Blends

Batch ID	total toxics mg/mi.	% reduc. toxics	total NO_x mg/mi.	% reduc. NO_x	total VOC mg/mi.	% reduc. VOC
0051	54.023	37.43	1127.058	15.89	1038.065	29.21
0052	53.703	37.80	1175.604	12.27	992.671	32.30
0053	55.309	35.94	1155.202	13.79	1045.575	28.69
0054	54.246	37.17	1150.07	14.17	1016.016	30.71
0055	56.737	34.29	1173.981	12.39	1025.477	30.06
0056	58.424	32.34	1180.476	11.90	1027.691	29.91
0057	51.549	40.30	1145.58	14.51	1016.879	30.65
0058	59.513	31.07	1183.136	11.71	1021.007	30.37
0059	56.324	34.77	1161.916	13.29	1061.07	27.64
0060	51.937	39.85	1146.926	14.41	1016.567	30.67
0061	60.897	29.47	1191.626	11.07	1028.754	29.84
0062	61.895	28.31	1208.198	9.84	1039.163	29.13
0063	60.636	29.77	1203.574	10.18	1039.971	29.08
0064	54.625	36.74	1200.047	10.44	1017.282	30.62
0065	52.298	39.43	1164.296	13.11	991.256	32.40
0066	56.046	35.09	1197.383	10.64	1033.807	29.50
0067	57.709	33.16	1204.716	10.10	1040.943	29.01

Table 9: Blend Stocks Blended with Ethanol

Batch ID	Octane Rating	RVP psi	Aromatic cont. (%)	Benzene cont. (%)	Olefins cont. (%)	D86 50% °F	D86 90% °F	Sulfur ppm	MtBE cont. (%)	EtBE cont. (%)	TAME cont. (%)	Methanol cont. (%)	Ethanol cont. (%)
0068	88.8	7.22	31	0.82	10.6	205	332	101	0	0	0	0	3.5
0069	89.6	7.19	32.6	0.82	9.8	211	335	85	0	0	0	0	3.5
0070	88.6	7.31	36.8	0.72	8.9	212	335	81	0	0	0	0	3.5
0071	88.4	7.5	33.3	0.68	10.2	209	334	105	0	0	0	0	3.5
0072	88.1	7.34	23.81	0.44	15.65	208	356	271	0	0	0	0	3.5
0073	87.3	7.19	31.3	0.74	10.7	219	333	120	0	0	0	0	3.5
0074	88	7.46	28.21	0.71	19.73	203	338	186	0	0	0	0	3.5

Table 10: Blend Stocks Blended with Ethanol

Batch ID	total toxics mg/mi.	% reduc. toxics	total NO_x mg/mi.	% reduc. NO_x	total VOC mg/mi.	% reduc. VOC
0068	61.791	25.76	1222.92	8.74	1103.88	24.72
0069	62.436	25.03	1211.86	9.56	1115.09	23.95
0070	63.539	24.01	1213.11	9.47	1153.18	21.36
0071	62.146	25.65	1227.91	8.37	1160.46	20.86
0072	60.659	28.27	1320.81	1.43	1119.11	23.68
0073	62.328	25.41	1231.00	8.13	1122.42	23.45
0074	62.786	24.83	1342.47	0.00	1118.12	23.75